FIG. 1.—The Solar Physics Observatory, Kodaikánal, India, 1905.

Solar physics—

(a) Observations of the six most widened lines in sun-spot spectra between *F* and *b*, and other six between *b* and *D*.

(b) Observations of the other widened lines in sun-spot spectra.

(c) Visual observations of prominences and chromosphere.

(d) Photographs of solar disk in monochromatic light.

(e) Photographs of sun-spot spectra.

Meteorological observations—

(f) Complete.

Other observations—

(g) Actinometry.

(h) Earthquake records.

(i) Cloud observations.

Magnetic observations—

It will be noticed that the above program does not include magnetic observations, and the list of instruments does not include the equipment of the magnetic observatory. From the Annual Report of the Director for 1904 we learn, however, that the following complete records are taken:

(a) Visually with the magnetometer and dip circle.

(b) By continuous photographic registration with a Watson magnetograph recording horizontal intensity and declination.

A base station is maintained at Periyakulam, three and one-half miles from the foot of the hills, or ten miles from Kodaikánal, at an elevation of about 935 feet, where a complete set of meteorological records is obtained.

The following publications of the observatory have been received at the Weather Bureau Library:

Annual Reports of the Director, Kodaikánal and Madras observatories, 1899–1905.

Kodaikánal Observatory, Bulletin No. I. Widened lines of sun-spot spectra.

The publication of the following bulletins has been announced:

No. II, containing a list of prominences observed between September 1, 1903, and December 31, 1904.

No. III, giving an account of the observations of D_3 as a dark line in the solar spectrum.

No. IV, which brings the record of sun-spot spectra up to the end of June, 1905.

Since January, 1903, the Indian Monthly Weather Review has contained in each issue a report from the Kodaikánal Observatory on the solar and magnetic disturbances of the month. In this report, as in the bulletins, special attention is paid to sun spots and prominences.

Important results are to be expected from an observatory organized on such broad lines. Its connection with the Meteorological Department of the government of India is but additional evidence of the broader field that is to be covered by the science of meteorology in the future. It is to be hoped that the rather discouraging experiences with the Balfour Stewart actinometer will not entirely prevent systematic measurements of solar radiation at the Kodaikánal Observatory, since other apparatus can undoubtedly be found.

HAWAIIAN MOUNTAIN RECORDS.

A letter from Prof. Dr. Julius Hann, dated December 2, 1905, calls attention to the fact that meteorology greatly needs observations from very high stations in the Hawaiian Islands.

You now have a station on Hawaii. This should give an opportunity for the determination of the circulation of the atmosphere at latitude 19° north, in about the middle of the ocean, that would be of the highest value. You can also observe the upper currents of air regularly, instead of occasionally, as is done in scientific expeditions like that of Hergesell and the Prince of Monaco. The existing observations made on Mauna Loa and Mauna Keua, at altitudes of about 4000 meters, give the same result as those made on the peak of Teneriffe, and can not be greatly influenced by local irregularities, as those obtained by Hergesell were influenced by the African Continent. I know that a long series of observations was made on the summit of Hawaii by the American geodesists. Can not these be published? They would be of the greatest interest. I think that I have read that on Mauna Loa, or possibly Mauna Keua, a long series of meteorological observations was made, but I can not find where the results were published. It would be of the greatest importance to our knowledge of the return upper trades, that Hergesell and Rotch could not find over the Atlantic Ocean, if the observations at great heights in Hawaii had been published. As Preston made gravity determinations at 3980 meters surely there must have been meteorological observations. A permanent station on Mauna Keua would certainly be a desideratum in meteorology.

It is greatly to be hoped that our Hawaiian observers will see what can be done toward discovering and publishing all the observations that have been made at great altitudes in Hawaii. The variations of rainfall, relative humidity, wind velocity, and cloudiness with altitude especially demand observation and study.—*C. A.*

THE PHOTOELECTRIC PROPERTIES OF SELENIUM CELLS.

By Prof. K. E. GUTHE, The State University of Iowa, Iowa City, Iowa. Dated May 14, 1906.

The recent application of the photoelectric properties of a selenium cell during the eclipse on August 30, 1905,[1] has again directed the attention of scientists to the selenium cell as a possible means for measuring intensity of illumination or its use for meteorological observations.

(1) The strongest objection to the use of any instrument for measuring light intensity lies in the fact that the latter is not a physical quantity in the strict sense of the word, but a subjective phenomenon, for which we have been unable so far to find any adequate unit of measurement. In all problems of this kind it should be well understood that usually we estimate luminosity by the subjective effect of light upon our eye, and it is apparent that the estimation of its intensity depends to a considerable extent upon the sensitivity of our eye to the various wave lengths and upon the distribution of the energy of radiation in the spectrum; at the same time, the impression made depends greatly upon the fatigue of the eye and upon after-images. In fact, the measurement of intensity of lights of different colors, or even different shades, is, from a physicist's point of view, a still unsolved problem. The only satisfactory method of determining the sensitivity of the eye consists in the comparison of the so-called threshold values, i. e., the energy of light of different wave lengths which will just be perceived as light by a well-rested eye. While these comparisons are usually made for the different rays of a given spectrum, it is clear that the relative distribution of energy in the spectrum must be taken into account in order to remove all uncertainty in the results, since different light sources show entirely different relative energy intensities of their components.

In the accompanying fig. 1 I have drawn the threshold values, as given by Ebert,[2] for the different colors of the spectrum, the energy of radiation being the same for all colors. It is claimed, however, that the form of the curve will vary with the intensity of the light. (Purkinje's phenomenon.[3])

Assuming for the sake of argument that the relative sensitivity of the eye for different colors remains unaltered by the degree of luminosity, the first condition to be fulfilled by an instrument intended as a substitute for the eye is that its relative sensitivity for different colors must be the same as for the eye. Pfund[4] has given us constant energy curves for the sensitiveness of selenium cells as a function of the wave length, i. e., curves showing the ratio of the change of electric conductivity to the original under the influence of the various spectral colors. I have reproduced one of them in fig. 1, taking (as in the first curve or that for the eye) the maximum sensitiveness as unity. A comparison between the two curves shows that the selenium cell is much more affected by red rays than by any other, while the eye is most sensitive to green. A reddish light will therefore appear much brighter to the selenium than to the eye, and a direct comparison of lights of different colors will always give unsatisfactory results if made by means of the selenium cells.[5]

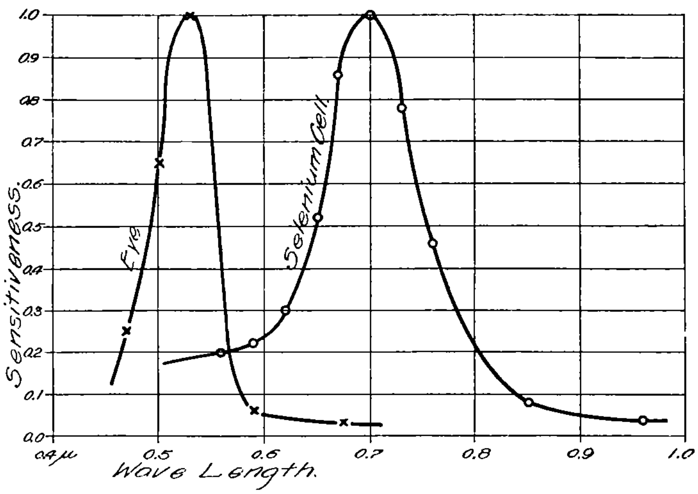

FIG. 1.—Sensitiveness of eye and selenium cell to light of different wave lengths.

The same objection can, however, be made to any other instrument for measuring intensity of illumination, for example, to the one used by Elster, Geitel, and Harms,[6] in which the results are obtained from the loss in quantity of electricity by a negatively charged metal plate when illuminated. In this case only wave lengths between 0.32μ and 0.50μ were used.

(2) Let us suppose that we select arbitrarily the selenium cell as the standard instrument for measuring luminosity; still other conditions must be fulfilled if the apparatus is to prove of value for our purpose. The relation between the intensity of light and the physical quantity from which we calculate the former must not be too complicated. Several attempts have been made to express the relative increase of conductivity as a function of the intensity of illumination. Hesehus[7] gives the following equation:

$$I = a(b^m - 1),$$

where I is the intensity, m the relative change of conductivity, a and b constants, which differ for different cells and even for the same cell vary considerably if the intensity is very strong. There is a great difference in the behavior of different types. The "hard" cells show great sensitiveness to variations in light if the latter is intense and much less for relatively weak illumination, while the "soft" cells show just the opposite. Thus, Ruhmer[8] found that the resistance of a hard cell fell with a change of luminosity from 0 to 4.6 lux 25 per cent and with a change from 22 to 20,000 lux 42 per cent, while the corresponding values for a soft cell were 56 and 25 per cent, respectively.

Every cell must, therefore, be calibrated empirically before any measurements can be made with it. It may be that the new method of preparing cells with pure selenium by using carbon instead of metal electrodes will lead to more constant results in this respect. Recent investigations[9] with such cells

[1] Wulf and Lucas, Phys. Zeitschr., 6, 838, 1905; Astroph. Journ., 23, 153, 1906.
[2] Ebert, Wied. Ann., 33, 150, 1888.
[3] Wundt, Physiologische Psychologie, 5th ed., II, 174.
[4] Pfund, Phil. Mag., 7, 26, 1904.
[5] Wulf and Lucas, l. c.
[6] Elster, Geitel, and Harms, Terrestr. Magnet., 11, 31, 1906.
[7] Hesehus, Phys. Zeitschr. 7, 163, 1906.
[8] Ruhmer, Phys. Zeitschr. 3, 470, 1902.
[9] Pfund, l. c.; Berndt, Phys. Zeitschr. 5, 121, 1904; Coste, C. R., 149, 715, 1905.